

Science Grade 11 Assessment Anchors and Eligible Content



Pennsylvania Department of Education

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S11.A The Nature of Science

Reporting Category

ASSESSMENT ANCHOR

S11.A.1 Reasoning and Analysis

ELIGIBLE CONTENT

S11.A.1.1 Analyze and explain the nature of science in the search for understanding the natural world and its connection to technological systems.

Reference: 3.1.10.A, 3.2.10.A, 3.1.10.E

S11.A.1.1.1 Compare and contrast scientific theories, scientific laws, and beliefs (e.g., the universal law of gravitation, how light travels, formation of moons, stages of ecological succession).

S11.A.1.1.2 Analyze and explain the accuracy of scientific facts, principles, theories, and laws.

S11.A.1.1.3 Evaluate the appropriateness of research questions (e.g., testable vs. not-testable).

S11.A.1.1.4 Explain how specific scientific knowledge or technological design concepts solve practical problems (e.g., momentum, Newton's universal law of gravitation, tectonics, conservation of mass and energy, cell theory, theory of evolution, atomic theory, theory of relativity, Pasteur's germ theory, relativity, heliocentric theory, ideal gas laws).

S11.A.1.1.5 Analyze or compare the use of both direct and indirect observation as means to study the world and the universe (e.g., behavior of atoms, functions of cells, birth of stars).

S11.A.1.2 Identify and analyze the scientific or technological challenges of societal issues; propose possible solutions and discuss implications.

Reference: 3.2.10.A, 4.3.10.B

S11.A.1.2.1 Explain and apply scientific concepts to societal issues using case studies (e.g., spread of HIV, deforestation, environmental health, energy).

S11.A.1.2.2 Use case studies (e.g., Wright brothers' flying machine, Tacoma Narrows Bridge, Henry Petroski's Design Paradigms) to propose possible solutions and analyze economic and environmental implications of solutions for real-world problems.

ASSESSMENT ANCHOR

S11.A.1 Reasoning and Analysis

ELIGIBLE CONTENT

S11.A.1.3 Describe and interpret patterns of change in natural and human-made systems.

Reference: 3.1.10.C, 3.1.10.E,
4.8.10.A

S11.A.1.3.1 Use appropriate quantitative data to describe or interpret change in systems (e.g., biological indices, electrical circuit data, automobile diagnostic systems data).

S11.A.1.3.2 Describe or interpret dynamic changes to stable systems (e.g., chemical reactions, human body, food webs, tectonics, homeostasis).

S11.A.1.3.3 Describe how changes in physical and biological indicators (e.g., soil, plants, animals) of water systems reflect changes in these systems (e.g. changes in bloodworm populations reflect changes in pollution levels in streams).

S11.A.1.3.4 Compare the rate of use of natural resources and their impact on sustainability.

S11.A The Nature of Science

Reporting Category

ASSESSMENT ANCHOR

S11.A.2 Processes, Procedures, and Tools of Scientific Investigations

ELIGIBLE CONTENT

S11.A.2.1 Apply knowledge of scientific investigation or technological design to develop or critique aspects of the experimental or design process.

Reference: 3.2.10.B, 3.2.10.D

S11.A.2.1.1 Critique the elements of an experimental design (e.g., raising questions, formulating hypotheses, developing procedures, identifying variables, manipulating variables, interpreting data, and drawing conclusions) applicable to a specific experimental design.

S11.A.2.1.2 Critique the elements of the design process (e.g. identify the problem, understand criteria, create solutions, select solution, test/evaluate, communicate results) applicable to a specific technological design.

S11.A.2.1.3 Use data to make inferences and predictions, or to draw conclusions, demonstrating understanding of experimental limits.

S11.A.2.1.4 Critique the results and conclusions of scientific inquiry for consistency and logic.

S11.A.2.1.5 Communicate results of investigations using multiple representations.

S11.A.2.2 Evaluate appropriate technologies for a specific purpose, or describe the information the instrument can provide.

Reference: 3.7.10.B, 3.8.10.B

S11.A.2.2.1 Evaluate appropriate methods, instruments, and scale for precise quantitative and qualitative observations (e.g., to compare properties of materials, water quality).

S11.A.2.2.2 Explain how technology (e.g., GPS, spectroscope, scanning electron microscope, pH meter, probe, interface, imaging technology, telescope) is used to extend human abilities and precision.

S11.A The Nature of Science

Reporting Category

ASSESSMENT ANCHOR

S11.A.3 Systems, Models, and Patterns

ELIGIBLE CONTENT

S11.A.3.1 Analyze the parts of a simple system, their roles, and their relationships to the system as a whole.

Reference: 3.1.10.A, 3.1.10.E, 4.3.10.C

S11.A.3.1.1 Apply systems analysis, showing relationships (e.g., flowcharts, concept maps), input and output, and measurements to explain a system and its parts.

S11.A.3.1.2 Analyze and predict the effect of making a change in one part of a system on the system as a whole.

S11.A.3.1.3 Use appropriate quantitative data to describe or interpret a system (e.g., biological indices, electrical circuit data, automobile diagnostic systems data).

S11.A.3.1.4 Apply the universal systems model of inputs, processes, outputs, and feedback to a working system (e.g., heating, motor, food production) and identify the resources necessary for operation of the system.

S11.A.3.2 Compare observations of the real world to observations of a constructed model.

Reference: 3.1.10.B, 3.2.10.B, 4.1.10.B, 4.6.10.A

S11.A.3.2.1 Compare the accuracy of predictions represented in a model to actual observations and behavior.

S11.A.3.2.2 Describe advantages and disadvantages of using models to simulate processes and outcomes.

S11.A.3.2.3 Describe how relationships represented in models are used to explain scientific or technological concepts (e.g., dimensions of objects within the solar system, life spans, size of atomic particles, topographic maps).

ASSESSMENT ANCHOR**S11.A.3 Systems, Models, and Patterns****ELIGIBLE CONTENT**

S11.A.3.3 Compare and analyze repeated processes or recurring elements in patterns.

Reference: 3.1.10.C, 3.2.10.B

S11.A.3.3.1 Describe or interpret recurring patterns that form the basis of biological classification, chemical periodicity, geological order, or astronomical order.

S11.A.3.3.2 Compare stationary physical patterns (e.g., crystals, layers of rocks, skeletal systems, tree rings, atomic structure) to the object's properties.

S11.A.3.3.3 Analyze physical patterns of motion to make predictions or draw conclusions (e.g., solar system, tectonic plates, weather systems, atomic motion, waves).

ASSESSMENT ANCHOR**S11.B.1 Structure and Function of Organisms****ELIGIBLE CONTENT**

S11.B.1.1 Explain structure and function at multiple levels of organization.

Reference: 3.3.10.A, 3.3.10.B, 4.6.10.A, 4.7.10.B

S11.B.1.1.1 Explain how structure determines function at multiple levels of organization (e.g., chemical, cellular, anatomical).

S11.B.1.1.2 Compare and contrast the structural and functional similarities and differences among living things (e.g., classify organisms into classification groups, compare systems).

S11.B.1.1.3 Compare and contrast cellular processes (e.g., photosynthesis and respiration, meiosis and mitosis, protein synthesis and DNA replication).

S11.B Biological Sciences

Reporting Category

ASSESSMENT ANCHOR
S11.B.2 Continuity of Life

ELIGIBLE CONTENT

S11.B.2.1 Explain the mechanisms of the theory of evolution.

Reference: 3.3.10.C, 3.3.10.D, 3.4.10.D, 4.7.10.C

- S11.B.2.1.1** Explain the theory of evolution by interpreting data from fossil records, similarities in anatomy and physiology, or DNA studies that are relevant to the theory of evolution.
- S11.B.2.1.2** Explain the role of mutations, differential reproduction, and gene recombination in changing the genetic makeup of a population.
- S11.B.2.1.3** Explain the role of selective breeding and biotechnology in changing the genetic makeup of a population.
- S11.B.2.1.4** Explain why natural selection can act only on inherited traits.

S11.B.2.2 Describe how genetic information is inherited and expressed.

Reference: 3.3.10.C

- S11.B.2.2.1** Describe how genetic information is expressed (i.e., DNA, genes, chromosomes, transcription, translation, and replication).
- S11.B.2.2.2** Compare and contrast mitosis and meiosis in passing on genetic information.
- S11.B.2.2.3** Explain how different patterns of inheritance affect population variability (i.e., multiple alleles, co-dominance, dominance, recessiveness, sex-influenced traits, and sex-linked traits).

ASSESSMENT ANCHOR

S11.B.3 Ecological Behavior and Systems

ELIGIBLE CONTENT

S11.B.3.1 Use evidence or examples to explain the characteristics of and interactions within an ecosystem.

Reference: 4.3.10.C, 4.6.10.A

S11.B.3.1.1 Explain the significance of diversity in ecosystems.

S11.B.3.1.2 Explain the biotic (i.e., plant, animal, and microbial communities) and abiotic (i.e., soil, air, temperature, and water) components of an ecosystem and their interaction.

S11.B.3.1.3 Describe how living organisms affect the survival of one another.

S11.B.3.1.4 Compare the similarities and differences in the major biomes (e.g., desert, tropical rain forest, temperate forest, coniferous forest, tundra) and the communities that inhabit them.

S11.B.3.1.5 Predict how limiting factors (e.g., physical, biological, chemical) can affect organisms.

S11.B.3.2 Analyze patterns of change in natural or human-made systems over time.

Reference: 3.1.10.C, 4.2.10.D, 4.3.10.B, 3.1.10.E, 4.3.10.C

S11.B.3.2.1 Use evidence to explain how cyclical patterns in population dynamics affect natural systems.

S11.B.3.2.2 Explain biological diversity as an indicator of a healthy environment.

S11.B.3.2.3 Explain how natural processes (e.g., seasonal change, catastrophic events, habitat alterations) impact the environment over time.

ASSESSMENT ANCHOR**S11.B.3 Ecological Behavior and Systems****ELIGIBLE CONTENT**

S11.B.3.3 Explain how human-made systems impact the management and distribution of natural resources.

Reference: 4.2.10.C, 4.4.10.C, 3.8.10.C

S11.B.3.3.1 Describe different human-made systems and how they use renewable and nonrenewable natural resources (i.e., energy, transportation, distribution, management, and processing).

S11.B.3.3.2 Compare the impact of management practices (e.g., production, processing, research, development, marketing, distribution, consumption, by-products) in meeting the need for commodities locally and globally.

S11.B.3.3.3 Explain the environmental benefits and risks associated with human-made systems (e.g., integrated pest management, genetically engineered organisms, organic food production).

ASSESSMENT ANCHOR

S11.C.1 Structure, Properties, and Interaction of Matter and Energy

S11.C.1.1 Explain the relationship between the structure and properties of matter.

Reference: 3.4.10.A

ELIGIBLE CONTENT

S11.C.1.1.1 Explain that matter is made of particles called atoms and that atoms are composed of even smaller particles (e.g., protons, neutrons, electrons).

S11.C.1.1.2 Explain the relationship between the physical properties of a substance and its molecular or atomic structure.

S11.C.1.1.3 Explain the formation of compounds (ionic and covalent) and their resulting properties using bonding theories.

S11.C.1.1.4 Explain how the relationships of chemical properties of elements are represented in the repeating patterns within the periodic table.

S11.C.1.1.5 Predict the behavior of gases through the application of laws (e.g., Boyle's law, Charles' law, or ideal gas law).

S11.C.1.1.6 Describe factors that influence the frequency of collisions during chemical reactions that might affect the reaction rates (e.g., surface area, concentration, catalyst, temperature).

S11.C Physical Sciences**Reporting Category****ASSESSMENT ANCHOR****S11.C.2 Forms, Sources, Conversion, and Transfer of Energy****ELIGIBLE CONTENT**

S11.C.2.1 Analyze energy sources and transfer of energy, or conversion of energy.

Reference: 3.4.10.B

S11.C.2.1.1 Compare or analyze waves in the electromagnetic spectrum (e.g., ultraviolet, infrared, visible light, X-rays, microwaves) as well as their properties, energy levels, and motion.

S11.C.2.1.2 Describe energy changes in chemical reactions.

S11.C.2.1.3 Apply the knowledge of conservation of energy to explain common systems (e.g., refrigeration, rocket propulsion, heat pump).

S11.C.2.1.4 Use Ohm's Law to explain relative resistances, currents, and voltage.

S11.C.2.2 Demonstrate that different ways of obtaining, transforming, and distributing energy have different environmental consequences.

Reference: 3.4.10.B, 4.8.10.C, 4.2.10.A

S11.C.2.2.1 Explain the environmental impacts of energy use by various economic sectors (e.g., mining, logging, transportation) on environmental systems.

S11.C.2.2.2 Explain the practical use of alternative sources of energy (i.e., wind, solar, and biomass) to address environmental problems (e.g., air quality, erosion, resource depletion).

S11.C.2.2.3 Give examples of renewable energy resources (e.g., wind, solar, biomass) and nonrenewable resources (e.g., coal, oil, natural gas) and explain the environmental and economic advantages and disadvantages of their use.

ASSESSMENT ANCHOR

S11.C.3 Principles of Motion and Force

ELIGIBLE CONTENT

S11.C.3.1 Use the principles of motion and force to solve real-world challenges.

Reference: 3.4.10.C, 3.6.10.C

S11.C.3.1.1 Explain common phenomena (e.g., a rock in a landslide, an astronaut during a space walk, a car hitting a patch of ice on the road) using an understanding of conservation of momentum.

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

S11.C.3.1.4 Explain how electricity induces magnetism and how magnetism induces electricity as two aspects of a single electromagnetic force.

S11.C.3.1.5 Calculate the mechanical advantage for moving an object by using a simple machine.

S11.C.3.1.6 Identify elements of simple machines in compound machines.

S11.D Earth and Space Sciences

Reporting Category

ASSESSMENT ANCHOR

S11.D.1 Earth Features and Processes that Change Earth and Its Resources

ELIGIBLE CONTENT

S11.D.1.1 Explain and analyze the forces in the lithosphere that continually shape Earth.

Reference: 3.5.10.A, 4.4.10.B, 4.1.10.B

S11.D.1.1.1 Classify and describe major types of rocks (i.e., igneous – granite, basalt, obsidian, pumice; sedimentary – limestone, sandstone, shale, coal; and metamorphic – slate, quartzite, marble, gneiss) and minerals (e.g., quartz, calcite, dolomite, clay, feldspar, mica, halite, pyrite) by their origin and formation.

S11.D.1.1.2 Explain the processes that take place at plate boundaries and how these processes continue to shape Earth (e.g., volcanic activity, earthquakes, mountain building, mid-ocean ridges, deep-sea trenches, new land being formed).

S11.D.1.1.3 Analyze features caused by the interaction of processes that change Earth’s surface (e.g., wind and moving water help break down rock into soil; plate movement, earthquakes, and volcanic activity help cause mountains and valleys to form; flowing water and deposition of material help form deltas).

S11.D.1.2 Analyze how human-made systems impact the management and distribution of natural resources.

Reference: 4.2.10.C, 3.5.10.B, 3.6.10.A

S11.D.1.2.1 Evaluate factors affecting availability, location, extraction, and use of natural resources.

S11.D.1.2.2 Explain the impact of obtaining and using natural resources for the production of energy and materials (e.g., resource renewal, amount of pollution, deforestation).

ASSESSMENT ANCHOR**S11.D.1 Earth Features and Processes that Change Earth and Its Resources****ELIGIBLE CONTENT**

S11.D.1.3 Explain the significance and contribution of water as a resource to living things and the shaping of the land.

Reference: 3.5.10.D, 4.1.10.B, 4.3.10.B

S11.D.1.3.1 Explain the multiple functions of different water systems in relation to landforms (e.g., buffer zones, nurseries, food production areas, habitat, water quality control, biological indicators).

S11.D.1.3.2 Explain relationships among physical characteristics, vegetation, topography, and flow as it relates to water systems.

S11.D.1.3.3 Explain factors (e.g., nutrient loading, turbidity, rate of flow, rate of deposition, biological diversity) that affect water quality and flow through a water system.

ASSESSMENT ANCHOR**S11.D.2 Weather, Climate, and Atmospheric Processes****ELIGIBLE CONTENT**

S11.D.2.1 Analyze how the transfer of energy and substances between Earth's atmosphere and its surface influences regional or global weather or climate.

Reference: 3.5.10.C

S11.D.2.1.1 Describe how changes in concentration of minor components (e.g., O₂, CO₂, dust, pollution) in Earth's atmosphere may be linked to climate change.

S11.D.2.1.2 Compare the transmission, reflection, absorption, and radiation of solar energy to and by Earth's surface under different environmental conditions (e.g., major volcanic eruptions, greenhouse effect, reduction of ozone layer, increased global cloud cover).

S11.D.2.1.3 Explain weather patterns and seasonal changes using the concepts of heat and density.

S11.D.2.1.4 Analyze weather maps and weather data (e.g., air masses, fronts, temperature, air pressure, wind speed, wind direction, precipitation) to predict regional or global weather events.

S11.D Earth and Space Sciences**Reporting Category****ASSESSMENT ANCHOR****S11.D.3 Composition and Structure of the Universe****ELIGIBLE CONTENT**

S11.D.3.1 Explain the composition, structure, and origin of the universe.

Reference: 3.4.10.D

S11.D.3.1.1 Describe planetary motion and the physical laws that explain planetary motion.

S11.D.3.1.2 Describe the structure, formation, and life cycle of stars.

S11.D.3.1.3 Explain the current scientific theories of the origin of the solar system and universe (e.g., big bang theory, solar nebular theory, stellar evolution).